REMARKS

Claims 28-30, 32, 34-36 and 63 are pending in this application. Claims 31 and 33 have been previously cancelled, and claims 37-62 have been withdrawn by the Examiner as directed to non-elected subject matter. Applicants expressly reserve the right to file one or more divisional applications directed to the non-elected subject matter.

According to the Office Action of April 11, 2008, claims 28-30, 32, 34-36 and 63 have been examined on their merits, and have been rejected. Applicants respectfully traverse the rejections for the reasons stated below.

Rejection Under 35 U.S.C. § 102

Claims 28-30, 34 and 63 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Publ. Pat. No. 2002/0081246 to Tsukada *et al.* ("Tsukada").

Tsukada is an improper reference under 35 U.S.C. § 102(b). According to MPEP § 706.02(a), to qualify as a reference under Section 102(b), that reference must have been published more than one year prior to the earliest effective filing date of the application. In this case, Tsukada was first published on June 27, 2002. However, the priority date claimed in this application is January 21, 2002, which is not more than 1 year after Tsukada's publication date.

Notwithstanding the above, Tsukada does not anticipate the recited invention because it does not teach each and every element recited in the claims. Tsukada is directed to a filter material comprising a fiber base (e.g. a glass fiber) having particles attached to the surface of the fiber to form surface protrusions at least on part of the fiber base. The protrusions are covered with a photocatalyst. The photocatalyst may be formed by sol-gel process, wash coating, vapor deposition, thermal decomposition, and the like (Tsukada at ¶ 34). The average particle diameter of the photcatalystic fine powders is preferably within the range of 5 and 1,000 nm (Tsukada at ¶ 79).

"Crystallite diameter" is not synonymous with "particle diameter" as used in Tsukada. The term "crystallite" is "a domain of solid-state matter that has the same structure as a single crystal. Metallurgists often refer to crystallites as 'grains.'" ("Crystallite", Wikipedia at http://en.wikipedia.org/wiki/Crystallite). Thus, except for a particle of a single

crystal or amorphous substance, a particle of a substance consists of a number of domains, each particle being regarded as a single crystal, and each domain being regarded as a crystallite.

Tsukada does not teach that the average domain size is 50 nm or smaller. Instead, it teaches a photocatalyst in the form of fine particles added to a binder solution to form a coating fluid, which is applied to the surface of the fiber base. The resulting film is a heterogenous film having fine photocatalyst particles dispersed in a binder matrix (Tsukada at ¶¶ 74-81).

In contrast, the invention as recited in the claims, is directed to a photocatalyst in the form of a homogenous continuous film formed solely from the photocatalyst material (titanium oxide). There are no particles in the photocatalyst recited in the claims.

The particle diameter referred to in Tsukada is the diameter of the photocatalyst particles that are dispersed in the coating matrix of the binder. Therefore, the particle diameter is different from the crystallite diameter recited in the claims.

Accordingly, Applicants respectfully request that this rejection be withdrawn.

Rejection Under 35 U.S.C. § 103

Claims 28-30, 32, 34-36 and 63 have been rejected under 35 U.S.C. § 103(a) as unpatentable over U.S. Pat. No. 5,919,422 to Yamanaka *et al.* ("Yamanaka") in view of U.S. Pat. No. 6,103,363 to Boire *et al.* ("Boire"). Applicants respectfully traverse this rejection because the cited references, taken as a whole, fail to teach or suggest that the individual fibers are coated with a continuous film, fail to teach or provide motivation to alter Yamanaka so that the particle size is 50 nm or smaller, and include a reference that is non-analogous prior art.

I. The cited references do not teach a continuous film.

The recited invention, is a photocatalytic composite material comprising a mass of inorganic fibers. The surfaces of the individual fibers are coated with a continuous film of photocatalyst. The continuous film is defined by the specification as a film that is "substantially free from peels, detachments and cracks" (specification at page 4, lines 8-16).

In pertinent part, the Office Action contends that the "the substrate of the curtain (181) is made from a glass-fiber woven cloth, which is coated with a continuous film (183 and 185) of titanium dioxide (a titanium oxide) photocatalyst (Column 24, lines 3-14)" (Office Action at page 3).

Yamanaka is directed to a vehicle curtain comprising a substrate 181, such as a curtain cloth, and a photocatalyst 183 and 185 on opposite surfaces of the substrate. Each photocatalyst 183 and 185 is a titanium dioxide film disposed continuously in a plane of the substrate 181. Yamanaka's "continuous film" would not be continuous as defined in the present specification. Yamanaka teaches preparing its film by a sol-gel method or film lamination (Yamanaka, column 25, lines 51-57). Film lamination cannot form a continuous film on the circumferential surface of each fiber. Nor can the sol-gel method, as evidenced by the present specification, Run No. 11 (see specification at page 21, lines 12-29).

In Run No. 11, sol-gel was tested as a wet process for Example 1. The resulting film was not a continuous film and had numerous discontinuities such as detached portions, steps and powder deposition (page 21, lines 20-26). Therefore, when the surface of minute fibers is concerned, a sol-gel method cannot form a continuous film.

The Office Action does not contend that Boire overcomes this deficiency. Moreover, Boire does not teach or suggest a continuous film covering a circumference of a fiber. Boire is directed to a photocatalytic coating that exhibits a marked dirt-repellent effect. The substrates in Boire are glass panels or ceramic substrates, which are planar. In Boire, the sol-gel technique and the CVD technique are alternatives to each other, and therefore Boire only teaches applying a film to a plane of the substrate. However, in the present invention, a continuous film cannot be formed by a sol-gel technique. Only a CVD method where the substrate is pre-heated in the range of 100° - 300°C forms the recited continuous film circumferentially around the fibers. Since Boire teaches using a sol-gel method, it is directed solely to applying a film on a plane of a substrate and does not suggest forming a continuous film circumferentially around a fiber.

In order for the cited references to make the recited invention obvious, they must teach or suggest a continuous film covering a mass of inorganic fibers. In this case, Yamanaka and Boire, viewed as a whole, do not teach such a film. Therefore, the Office

Action has failed to make a *prima facie* showing that the cited references, taken as a whole, teach or suggest a continuous photocatalytic film covering the circumferential surfaces of a mass of fibers, as recited in the subject claims. Accordingly, reconsideration and withdrawal of this rejection is respectfully requested.

On page 6, the Office Action contends that the Applicants have not provided proof or argument that the vapor deposited coating of Yamanaka is not continuous. First, Applicants respectfully disagree that Applicants carry the burden of establishing that Yamanaka's film is not continuous. Moreover, it is apparent from the text of Yamanaka that Yamanaka's film is not continuous.

Yamanaka's thirteenth preferred embodiment (figures 17 and 18), which is specifically relied upon in the Office Action, is directed to a vehicle curtain comprising a substrate 181, such as a curtain cloth, and a photocatalyst 183 and 185 on opposite surfaces of the substrate. Each photocatalyst 183 and 185 is a titanium dioxide film disposed continuously in a plane of the substrate 181 (Yamanaka, column 25, lines 3-9). The plane is each of the opposite surfaces of the cloth substrate, and not the surface of the individual fibers constituting the substrate. This is also supported by Yamanaka at column 25, lines 30-32, which indicates that the substrate 181 has opposite planar surfaces separated by a curtain thickness and the photocatalysts 183 and 185 are disposed on both of the opposite surfaces of the substrate. Since only the plane of the substrate is coated in Yamanaka, and not the individual fibers, Yamanaka's "continuous film" would not be continuous as defined in the present specification. Therefore, the recited invention is not obvious because the combination of Yamanaka and Boire does not teach a continuous film as defined by the specification.

II. Particles 50 nm or smaller are not obvious in view of the cited references.

Claims 28-30, 32, 35-36 and 63, also recite the average crystallite diameter of 50 nm or smaller. This limitation is not obvious in view of the cited references.

As acknowledged on page 6 of the Office Action, Yamanaka does not inherently teach crystallites having an average size as recited in the claims. It is not clear how the Office Action establishes that the recited crystallite size would have been obvious to a person of ordinary skill in the art. As discussed below, the references would not motivate a

person of ordinary skill in the art to develop the recited photocatalytic composite material because the combination of the references would not lead such a person to a method capable of producing the recited photocatalytic composite material.

The invention recited in claim 28 is prepared by initially preheating a mass of inorganic fibers to 100° – 300°C, contacting the vapors for CVD (titanium tetrachloride and water vapors), and then further heating the crystallization of the coated film to form a crystalline titanium oxide film (see specification example 1, pages 18-21; and example 3, pages 25-27). If the temperature of the preheated substrate at the time of CVD is higher than 300°C, the resulting titanium oxide film has an average crystallite diameter larger than 50 nm, poor adhesion, and decreased photocatalytic activity, as evidenced by the specification at Table 1 (No. 10) and Table 2. If the temperature of the preheated substrate at the time of CVD is lower than 100°C, the film will have cracks, poor adhesion, and therefore will not be continuous and will have decreased photocatalytic activity (see specification at Table 1, No. 5; and Table 2).

Yamanaka discloses a titanium dioxide film applied by vapor phase growth process, such as a vacuum deposition process or a chemical precipitation process, and is calcined to form a photocatalyst. However, according to this process, the particles would be far greater than 50 nm. The calcination can be done by preheating the substrate prior to vapor phase growth for simultaneous film formation and calcination, by heating and vapor phase growth simultaneously, or by heating the substrate after vapor phase growth. In Yamanaka, the calcination temperature is between 600° and 700°C. At this temperature, the average size of the crystallite would be larger than 50 nm. For example, Run No. 10 in the specification (page 21) provides that when the substrate is preheated to 400°C, the average crystallite diameter is far greater than 50 nm. It is therefore expected that preheating the substrate to 600° or 700°C would also produce average crystallite diameter far greater than 50 nm. As such, Yamanaka does not inherently teach a film having an average crystallite size of 50 nm or smaller because Yamanaka's film has an average crystallite size far greater than 50 nm.

A photocatalytic film on a mass of inorganic fibers having an average crystallite diameter of 50 nm or less is not obvious in view of Yamanaka and Boire because there is no motivation to combine the references. "[A] patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently,

known in the prior art." *KSR Int'l.*, 127 S.Ct. 1727, 1741. "[I]t can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does". *Id.* Examples of rationales to support a *prima facie* showing of obviousness are provided in MPEP (Rev. Sept. 6, 2007) § 2143:

> (A) Combining prior art elements according to known methods to yield predictable results;
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> (B) Simple substitution of one known element for another to obtain predictable results;
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> (C) Use of known technique to improve similar devices (methods, or products) in the same way;
>
> (D) Applying a known technique to a known device (method, or product) ready for improvement to yield predictable results;
>
> (E) "Obvious to try" – choosing from a finite number of identified, predictable solutions, with a reasonable expectation of success;
>
> (F) Known work in one field of endeavor may prompt variations of it for use in either the same field or a different one based on design incentives or other market forces if the variations are predictable to one of ordinary skill in the art;
>
> (G) Some teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill to modify the prior art reference or to combine prior art reference teaching to arrive at the claimed invention.
>
> The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR* noted that the analysis supporting a rejection under 35 U.S.C. 103 should be made explicit.

The reasoning behind this requirement is to ensure that hindsight is not used. MPEP § 2145.

The Office Action fails to provide any reason to combine Yamanaka and Boire. Instead, it merely states that "it would be obvious to one of ordinary skill in the art to form crystals of this size, as taught by Boire, in order to maximize the photocatalytic effect" (Office Action at page 4). However, mere conclusory statements are insufficient to establish the requisite motivation. See MPEP § 2141, *citing In re Kahn* 441, F.3d 977, 988 (Fed. Cir. 2006).

Although the Applicants are not required to establish a lack of motivation to combine the references, it is apparent that one of ordinary skill in the art would not be compelled to combine the teachings of Yamanaka and Boire to develop a film according to Yamanaka that has the size characteristics of Boire. In order to accomplish this, there must be some motivation to alter Yamanaka's temperature parameters and method of applying the film. The Office Action contends that "Boire (Column 2, lines 5-30) further teaches that crystallites should have an average size of between 0.5 and 100 nm, preferably 1 to 50 nm, in order to have optimum photocatalytic effect" (Office Action at page 4). However, this does not provide any motivation to reduce the temperature to 100° – 300°C in Yamanaka's procedure, or to use CVD instead of the sol-gel or film lamination processes, two critical elements necessary to achieve the recited particle size. Moreover, Boire fails to provide the requisite motivation to alter Yamanaka. Boire is directed to a glass or ceramic substrate having a photocatalytic coating on at least a portion of its surfaces. The coating formed by thermal decomposition of a titanium precursor such as organo-metallic precursors or metallic halide precursors, wherein the crystalline size of the titanium oxide is preferably 1-50 nm. Deposition by CVD from titanium tetrachloride is one technique disclosed in Boire (column 1, lines 53-65). However, as illustrated in the specification at examples 4-7, the deposition is carried out at approximately 425°C. Boire does not provide motivation to reduce Yamanaka's temperature to 100° - 300°C; thus, there is no motivation to combine the references or modify Yamanaka to produce particle sizes that are 50 nm or smaller.

To further illustrate that the combination of Yamanaka and Boire would not lead a skilled artisan to a method capable of producing the recited photocatalytic composite materials, on column 26, lines 15-50, Yamanaka refers to a vapor-phase growing process such as a vacuum deposition process or a chemical precipitation process to deposit a titanium dioxide film layer on the ***opposite surface*** of the substrate 181. The resulting titanium dioxide film layer is calcined to form the desired photocatalyst. The calcination can be done by (1) preheating the substrate to a predetermined temperature at which vapor-phase deposition and calcination are performed simultaneously, (2) performing vapor phase deposition and heating simultaneously, or (3) initially performing vapor phase deposition followed by heating for calcination.

In contrast, the claimed invention can be formed on the surface of the individual fibers by a process including a preheating step, a chemical vapor deposition step with $TiCl_4$, and a further heating step. As shown in Table 1, preheating of a substrate (fiber mass) in a relative low temperature range is essential to form a continuous film on the surface of each fiber in the fiber mass such as cloth or wool. The substrate temperature of 25°C in this table indicates no preheating, and the resulting film in this case was not continuous.

Thin fibers have an extremely small radius of curvature, so a film formed thereon is susceptible to cracking. Therefore, preheating before vapor deposition and subsequent heating, or two-step heating is essential to form a continuous film on the surfaces of the individual fibers of a fiber mass even when the film is formed by chemical vapor deposition, which produces a relatively small stress to the resulting film during film formation.

Such two-step heating including preheating of a substrate to be coated and post-deposition heating at different temperatures is not taught or suggested by Yamanaka or Boire. Although Boire refers to heating of the annealing type to which a coating is subjected, this is essential for a technique of a sol-gel process (Boire at column 8, lines 5-8). The CVD method is illustrated in the present specification at examples 4-7, in which vapor deposition was carried out at about 425°C without further heating. Thus, Boire does not teach or suggest a two-step heating process necessary to form a continuous photocatalyst film on the surface of the individual fibers of the fiber mass.

III. The cite references are not analogous to the invention.

Boire is directed to coating a planar surface, not an inorganic mass of fibers. (Boire at column 1 lines 6-11). According to MPEP § 2141.01(a),

> The examiner must determine what is "analogous prior art" for the purpose of analyzing the obviousness of the subject matter at issue. "Under the correct analysis, any need or problem known in the field of endeavor at the time of the invention and addressed by the patent [or application at issue] can provide a reason for combining the elements in the manner claimed." *KSR International Co. v. Teleflex Inc.*, 550 U.S. ___, ___, 82 USPQ2d 1385, 1397 (2007). Thus a reference in a field different from that of applicant's endeavor may be reasonably pertinent if it is one which, because of the matter with which it deals, logically would have commended itself to an inventor's attention in considering his or her invention as a whole.

In the present invention, the coating is applied circumferentially to the fibers. Thus, Boire is not within the field of endeavor of coating fibers. Nor has the Office Action explained why a skilled artisan logically would have commended himself or herself to this reference when working on the invention at hand. There is no explanation why a skilled artisan trying to coat a three-dimensional fiber with a continuous coat would look to a reference directed to coating planar objects.

Thus, Boire cannot be used to support a rejection under 35 U.S.C. §103.

CONCLUSION

In view of these remarks, Applicants respectfully submit that all pending claims in the instant application are patentable over the prior art and are in condition for allowance. Accordingly, reconsideration and withdrawal of the rejections and a Notice of Allowance are respectfully requested. Should the Examiner have any questions or concerns, the Examiner is invited to contact Applicants' undersigned attorney by telephone at 412-471-8815.

Respectfully submitted,

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